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REMARKS

Reconsideration and withdrawal of the objections and rejections set forth in the above-mentioned Official Action in view of the foregoing amendments and the following remarks are respectfully requested.

The drawings were objected to on various grounds. These objections are traversed for the following reasons.

The Examiner suggested that several reference signs mentioned in the description were not shown in the drawings. As to reference numeral 31, Figure 2 is proposed to be amended to include this symbol. As to the remaining reference signs, they represent pixel positions and do not reflect reference characters in the drawings.

The drawings were further objected to for including several references signs allegedly not mentioned in the description. The specification has been amended herein to include a paragraph at page 27, after line 26 of the specification, describing steps S106, S107, and S111 to S113. Steps S121 and S122 are included in "steps S120 to S123" at page 28, line 26 of the specification.

The drawings were also objected to for allegedly not showing certain features recited in the claims. Applicants respectfully submit that all the features noted by the Examiner are represented in the drawings. For example, the means for storing the first and second tables respectfully correspond to storage medium 4 in Figure 1. The designation means corresponds to storage medium 4 and CPU 3 therein. The selection means and the control means can read on image processor 6 of Figure 1.

In view of the foregoing, reconsideration and withdrawal of the objection to the drawings are requested.

The disclosure was objected to for minor informalities. The specification has been amended at pages 12 and 20 in the manner suggested by the Examiner. Accordingly, reconsideration and withdrawal of the objection to the disclosure are requested.

Claims 1-14 are now pending in the application, with Claims 1, 9 and 13 being independent. Claims 1, 2, 4-10, 12 and 13 have been amended and Claim 14 has been added herein.

Applicant notes with appreciation the indication that Claims 2 and 10 recite allowable subject matter. These claims were objected to for being dependent upon rejected base claims. However, these claims will not be rewritten in independent form at this time because their respective independent claims are believed to be allowable for the reasons discussed below.

Claims 1, 9 and 13 were rejected under 35 U.S.C. § 103 as being unpatentable over U.S. Patent No. 5,111,302 (Chan et al.) in view of U.S. Patent No. 6,164,747 (Yashima et al.). Claims 3 and 11 were rejected under § 103 as being unpatentable over Chan et al. in view of Yashima et al. and further in view of U.S. Patent No. 4,651,287 (Tsao). Claims 4 and 12 were rejected under § 103 as being unpatentable over Chan et al. in view of Yashima et al. and further in view of U.S. Patent No. 4,714,964 (Sasaki) and Tsao. Claim 5 was rejected under § 103 as being unpatentable over Chan et al. in view of Yashima et al. and further in view of U.S. Patent No. 6,193,347 (Askeland et

al.). Claim 6 was rejected under § 103 as being unpatentable over Chan et al. in view of Yashima et al. and further in view of Askeland et al. and U.S. Patent No. 4,680,645 (Dispoto). Claim 7 was rejected under § 103 as being unpatentable over Chan et al. in view of Yashima et al. and further in view of U.S. Patent No. 6,338,538 (Toshiaki). Claim 8 was rejected under § 103 as being unpatentable over Chan et al. in view of Yashima et al. and further in view of Askeland et al. and U.S. Patent No. 6,354,688 (Inoue). These rejections are respectfully traversed.

Independent Claims 1, 9, and 13 are directed to an ink jet printing apparatus, and ink jet printing method, and a computer readable memory, respectively. Each independent claim recites, inter alia, a first table indicating a pixel density distribution pattern where a pixel density distribution within predetermined pixels is patterned, a second table indicating combinations of density distribution patterns of print pixels and the ink ejection print elements in correspondence with gray scale values, designating a region consisting of a predetermined number of neighboring pixels from pixels that form an input image, and selecting the pixel density distribution pattern for the designated region from the first table. The claims further recite controlling ejection/non-ejection of ink from the plurality of ink ejection print elements by looking up the second table in accordance with the selected pixel density distribution pattern and a gray scale value thereof.

With the present invention, the first table indicates a pixel density distribution pattern where a pixel density distribution within predetermined pixels is patterned. With this arrangement, each pixel density distribution pattern can represent an identical gray scale value with different two-by-two pixel arrangements, each of which can

have various gray scale values at different pixel positions within the two-by-two matrix. A pixel density distribution pattern corresponding to a region of an input image to be processed can be selected from the first table based on a pixel value of the region. The second table indicates combinations of density distribution patterns and ink ejection print elements in correspondence with gray scale values. Accordingly, ink ejection print elements to be used for printing can be designated on the basis of a pixel density distribution pattern corresponding to the region of the input image and gray scale values of the region. Thus, a region of an input image corresponding to a pixel density distribution pattern can define a print pixel to be printed by ink ejection elements, and the pixel density distribution pattern can be selected for each of the print pixels of the input image. As a result, the information size of the image data can be reduced without decreasing the resolution of the printed image. Further, a high-speed image print process and a load reduction on the controller can be attained when ink ejection print elements are selected on the basis of a combination of densities of ink, ink droplet amounts or the like.

Chan et al. relates to a method of gray scale printing of dots of one or more colors into pixels. One or more levels of dot loading can be used to achieve different values of gray level. Applicants submit that although Chan et al. can define one print pixel with plural pixels, there is no disclosure or suggestion of a first table indicating a pixel density distribution density pattern where a pixel density distribution within predetermined pixels is patterned, as is recited in independent Claims 1, 9, and 13.

Thus, Chan et al. fails to disclose or suggest important features of the present invention recited in the independent claims.

Yashima et al. describes a recording apparatus and method that includes an ink density data/combination data unit. The apparatus includes a memory for storing density levels as well as information corresponding to combinations of recording agents which express the density levels, and multi-level conversion means. However, Yashima et al. is also not believed to disclose or suggest the first table recited in independent Claims 1, 9, and 13. Thus, Yashima et al. fails to remedy the deficiencies of Chan et al. noted above with respect to the independent claims.

The remaining citations have also been reviewed but are also not believed to disclose or suggest these features, individually or in combination.

Thus, independent Claims 1, 9 and 13 are patentable over the citations of record. Reconsideration and withdrawal of the § 103 rejections are respectfully requested.

For the foregoing reasons, Applicant respectfully submits that the present invention is patentably defined by independent Claims 1, 9 and 13. Dependent Claims 2-8, 10-12 and 14 are also allowable, in their own right, for defining features of the present invention in addition to those recited in their respective independent claims. Individual consideration of the dependent claims is requested.

Applicant submits that the present application is in condition for allowance. Favorable reconsideration, withdrawal of the objections and rejections set forth in the above-noted Office Action, and an early Notice of Allowance are requested.

Applicant's undersigned attorney may be reached in our Washington, D.C. office by telephone at (202) 530-1010. All correspondence should continue to be directed to our below-listed address.

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE TO SPECIFICATION

The paragraph beginning at page 5, line 8 and ending at line 15, has been amended as follows.

--Error diffusion binarizes multi-valued image data of a pixel of interest (converts it into the darkest or lightest level), and distributes and adds the difference (error) between the converted binary level and the value before binarization to surrounding pixels, as described in, e.g., R. FLOYD & L. STEINBERG, "AN ADAPTIVE ALGORITHM FOR SPATIAL [SPECIAL] GRAY SCALE", SID 75 DIGEST, pp. 36 - 37.--.

The paragraph beginning at page 12, line 6 and ending at line 11, has been amended as follows.

--A preferred embodiment of the present invention will be described in detail hereinafter with reference to the accompanying drawings. Note that [a] "density" hereinafter means an optical density of ink [land] landed on a printing medium. Further, [a] "multi-density" ink means that there are different optical densities of inks.--.

The paragraph beginning at page 20, line 19 and ending at line 23, has been amended as follows.

--The aforementioned print elements are driven based on a predetermined print signal in accordance with the read timing of the linear encoder 28, and form an image by making ink droplets fly and become [attach] attached onto the print sheet 24.--.

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VERSION WITH MARKINGS TO SHOW CHANGES MADE TO CLAIMS

1. (Amended) An ink-jet printing apparatus for printing a visible image on a print medium by discharging ink from a plurality of ink ejection print elements, comprising:

means for storing a first table indicating [a correspondence between a plurality of inks and gray scale values of print pixels] a pixel density distribution pattern where a pixel density distribution within predetermined pixels is patterned;

means for storing a second table indicating combinations of density distribution patterns of print pixels and the ink ejection print elements in correspondence with [the] gray scale values;

designation means for designating a region consisting of a predetermined number of neighboring pixels from pixels that [forms] form an input image;

selection means for selecting the pixel density distribution pattern for the designated region from the first table; and

control means for controlling [ink] ejection/non-ejection of ink from the plurality of ink ejection print elements by looking up the [first and] second [tables] table in accordance with the pixel density distribution pattern selected by the selection means and a gray scale value thereof.

2. The apparatus according to claim 1, wherein said control means looks up the first and second tables on the basis of a value near a value obtained by

dividing a sum total of gray scale values of pixels which [forms] form the region by the predetermined number of pixels.

4. (Amended) The apparatus according to claim 1, wherein a plurality of combinations of density distribution patterns of the print [pixel] pixels and ink ejection print elements are prepared for a single gray scale value, and said control means sequentially or randomly selects these combinations.

5. (Amended) The apparatus according to claim 1, wherein said control means controls [adopts] an ink-jet printing method of discharging double ink droplets onto at least a single unit pixel, and prints the visible image by discharging one or plurality of ink droplets onto the unit pixel.

6. (Amended) The apparatus according to claim 1, wherein said control means [adopts] controls an ink-jet printing method of discharging ink droplets having at least two different dot sizes, and prints the visible image by discharging one or plurality of ink droplets onto a unit pixel.

7. (Amended) The apparatus according to claim 1, wherein said control means [adopts] controls an ink-jet printing method of discharging at least two multi-density ink droplets for the same hue, and prints the visible image by discharging one or plurality of ink droplets onto a unit pixel.

8. (Amended) The apparatus according to claim 1, wherein the plurality of ink ejection print elements are integrated and [line up] aligned, and express a halftone image by [controlling] causing a plurality of ink dots to land on substantially a single print pixel on [a] the print medium when they are scanned a plurality of number of times in a scan direction different from [the line-up] an alignment direction while being moved relative to [a] the print medium by a predetermined width in a direction different from the scan direction.

9. (Amended) An ink-jet printing method for printing a visible image on a print medium by discharging ink from a plurality of ink ejection print elements, comprising:

a first table providing step of providing a first table indicating a pixel density distribution pattern where a pixel density distribution within predetermined pixels is patterned;

a second table providing step of providing a second table indicating combinations of density distribution patterns of print pixels and the ink ejection print elements in correspondence with gray scale values;

[the] a designation step of designating a region consisting of a predetermined number of neighboring pixels from pixels that [forms] form an input image;

[the] a selection step of selecting a pixel density distribution pattern for the designated region from the first table; and

[the] a control step of controlling [ink] ejection/non-ejection of ink from the plurality of ink ejection print elements by looking up [a first] the second table [indicating a correspondence between a plurality of inks and gray scale values of print pixels and a second table indicating combinations of density distribution patterns of print pixels and the ink ejection print elements in correspondence with the gray scale values] in accordance with the pixel density distribution pattern selected in the selection step and a gray scale value thereof.

10. (Amended) The method according to claim 9, wherein the control step includes the step of looking up the first and second tables on the basis of a value near a value obtained by dividing a sum total of gray scale values of pixels which [forms] form the region by the predetermined number of pixels.

12. (Amended) The method according to claim 9, wherein a plurality of combinations of density distribution patterns of the print [pixel] pixels and ink ejection print elements are prepared for a single gray scale value, and the control step includes the step of sequentially or randomly selecting these combinations.

13. (Amended) A computer readable memory that stores a program code of an ink-jet print process for printing a visible image on a print medium by discharging ink from a plurality of ink ejection print elements, comprising:

a program code of a first table providing step of providing first table indicating a pixel density distribution pattern where a pixel density distribution within predetermined pixels is patterned;

a program code of a second table providing step of providing a second table indicating combinations of density distribution patterns of print pixels and the ink ejection print elements in correspondence with gray scale values;

a program code of [the] a designation step of designating a region consisting of a predetermined number of neighboring pixels from pixels that [forms] form an input image;

a program code of [the] a selection step of selecting a pixel density distribution pattern for the designated region from the first table; and

a program code of [the] a control step of controlling [ink] ejection/non-ejection of ink from the plurality of ink ejection print elements by looking up [a first] the second table [indicating a correspondence between a plurality of inks and gray scale values of print pixels and a second table indicating combinations of density distribution patterns of print pixels and the ink ejection print elements in correspondence with the gray scale values] in accordance with the pixel density distribution pattern selected in the selection step and a gray scale value thereof.

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